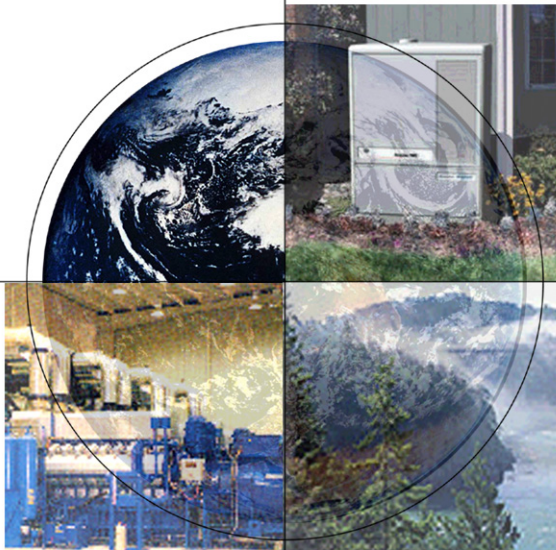


Planning Considerations for an Animal Waste (dairy) Anaerobic Digester/ Micro-Turbine Combined Heat and Power (CHP) Application



ASME TURBO EXPO 2003: Power for Land, Sea and Air

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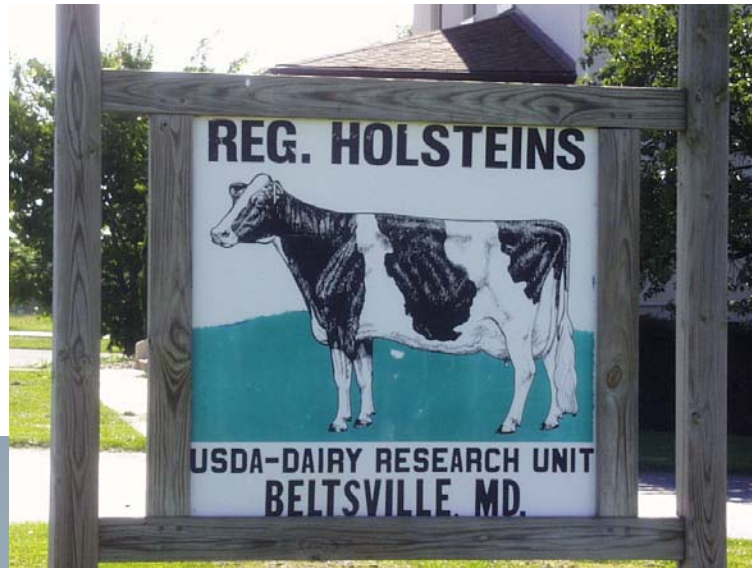
National Energy Technology Laboratory



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USDA-ARS, US-DOE Office of Bio-Powers and National Energy Technology Laboratory are evaluating micro-turbine generator technology at the Beltsville, MD ARS Dairy Manure Digester.



Research Objectives

❖ Power Generation

❖ Fuel analysis

- (bio-gas + blended gas scenarios)
- Power generation
- Exhaust gas analysis

❖ System Economy

- Capital costs
- Operating costs
- Return on investment

❖ Economy of Scale

- Number of animals
- Local power cost



Potential Areas of Analysis

Energy and Environment

- ❖ Raising Herd Replacements
- ❖ Farm Travel
- ❖ Manure Handling and Storage
- ❖ Crop Production
- ❖ Milking, Milk Cooling, and Water Heating
- ❖ Selection, Maintenance, and Operation of Energy Efficient Farm Equipment
- ❖ Ventilation
- ❖ Lighting
- ❖ Identify Potential to Decrease Current Fossil Energy Use
- ❖ Supplement Energy Demands with Bioenergy
- ❖ Definition and Analysis of Energy Use Options
- ❖ Implementation



Initial Design and Operations Considerations

- ❖ The digester was originally designed for odor control.
- ❖ Two gas boilers installed-one for natural gas as needed-one for biogas base load
- ❖ Boilers output temp limited by PVC piping used in digester heating system



Initial Design and Operations Considerations



Design

- ❖ Capacity 250 cows
- ❖ Retention time 23 days
- ❖ Primary purpose odor control
- ❖ Less than required Methane produced to maintain less than desired heat for the digester, system augmented with natural gas

System Evaluation

Roots flow meter



Digital Temp
readout

Digital gas flow
meter

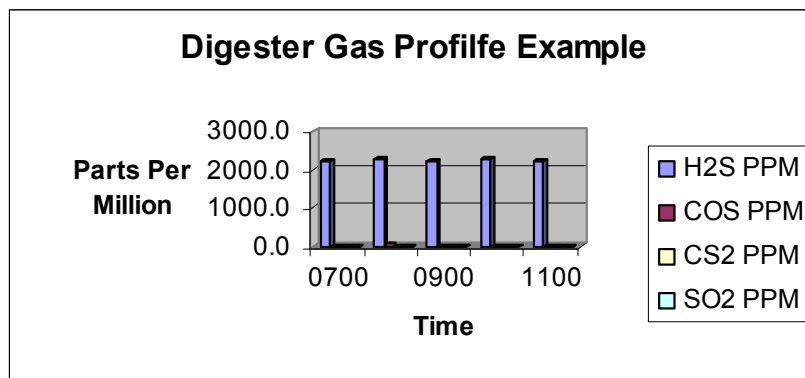
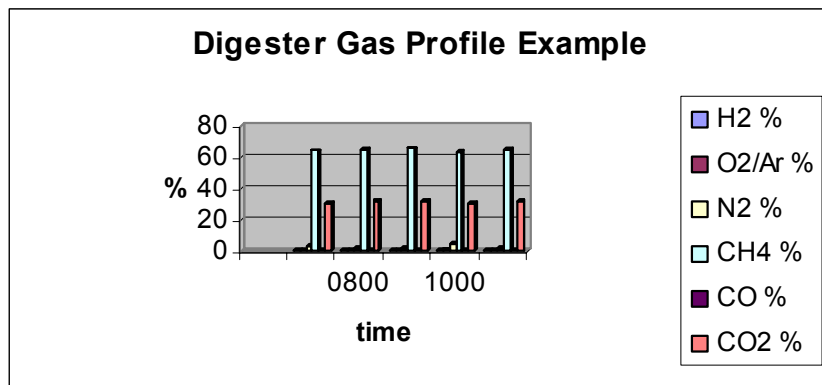


Non-metallic piping



Periodic gas sampling

Digester Gas Profile Example



System Evaluation

Milking Parlor



Power meter installed

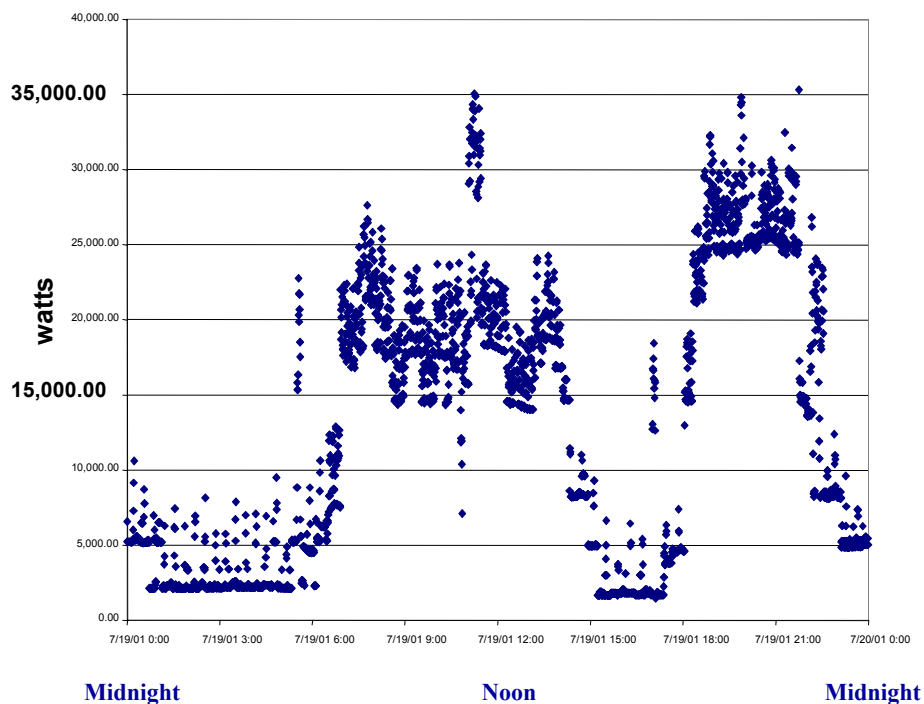
Barn



Energy Usage

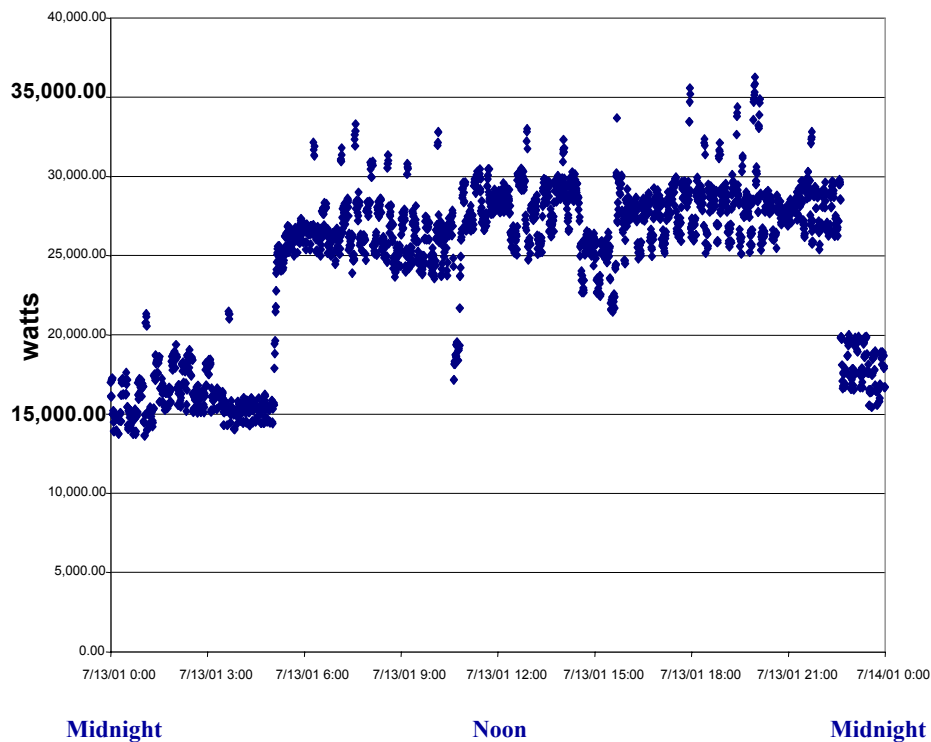
Dairy Parlor

Milking Parlor Power Profile for One Day



Energy Usage Dairy Barn

Barn Power Profile for One Day



Updated Design and Operations Considerations



Current

- ❖ 130 cows & heifers
- ❖ Purpose odor control and improved methane production (~12 kW)
- ❖ Methane used to fuel micro-turbine CHP
- ❖ Electric to power barn lighting and fans
- ❖ Heat to improve digester performance

Today

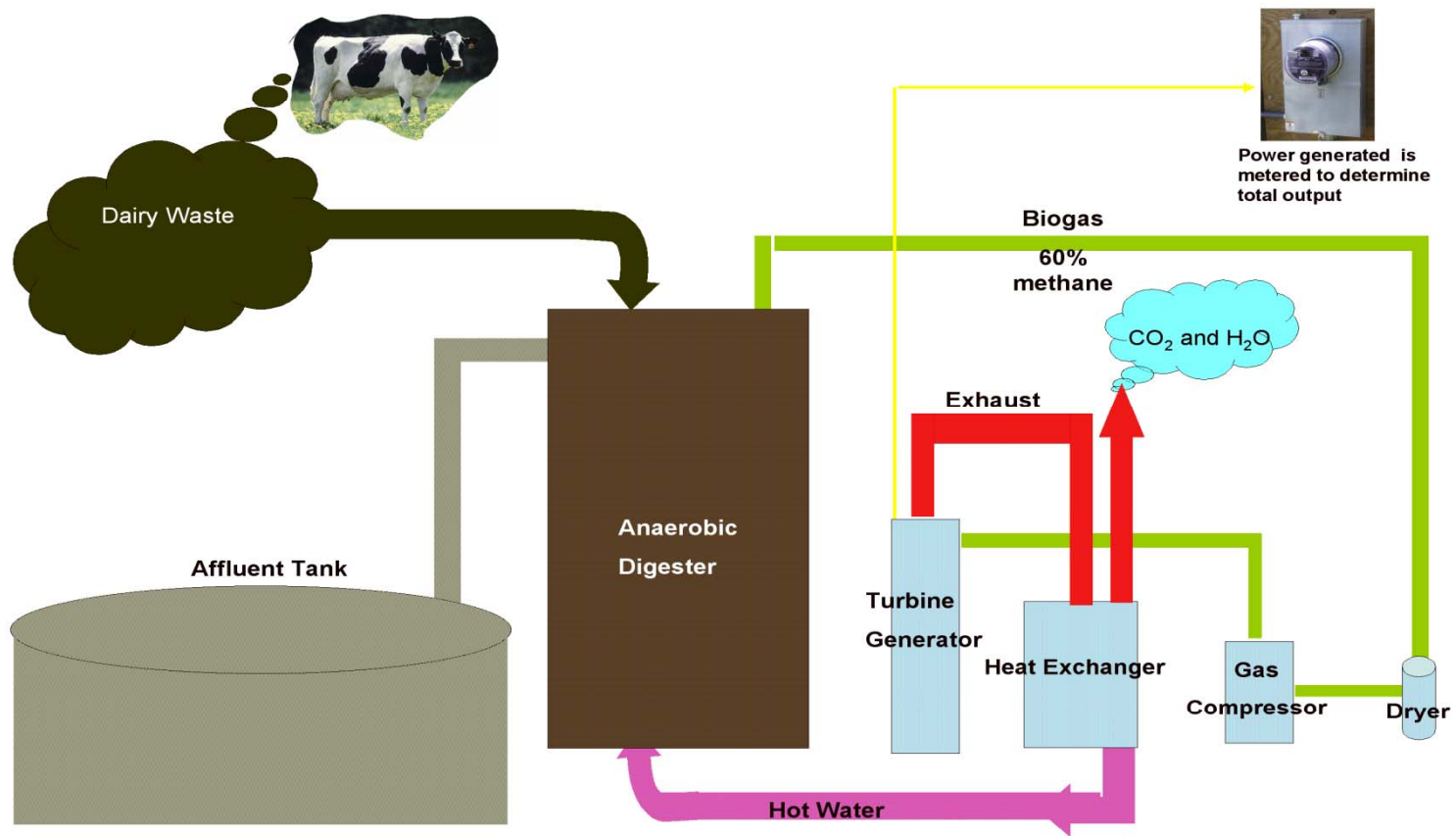


Process Flow

Electric Co-Generation from Dairy Waste Biogas

U. S. Department of Agriculture, Beltsville Agricultural Research Center, Animal and Natural Resources Institute, Beltsville, MD

U.S. Department of Energy, National Energy Technology Laboratory, Pittsburgh, PA



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❖ Lessons Learned

❖ Equipment Selection

- ❖ Capstone 30 kW
- ❖ Stand Alone Option ?
- ❖ Transformers ?
- ❖ Heat Exchanger

❖ Gas Issues

- ❖ Dry Gas !
- ❖ Filtered Gas !
- ❖ Improved Bio-Gas Production-Higher Digester Temperature
 - ❖ Pre-Heat Liquid Stream Into Digester

❖ Operator/Farmer Acceptance

❖ Operating Environment

❖ Future Plans

❖ Gas Issues

- ❖ Gas Blending
 - ❖ Natural Gas-Economics
 - ❖ Propane-Economics

❖ Digester Performance

- ❖ Pre-Heat Liquid Stream
- ❖ Shredder Value
 - ❖ Plugging of solids

❖ Operator/Farmer Acceptance

- ❖ Farmers Know IC Engines
- ❖ Prove Reliability
- ❖ Prove Less Maintenance
- ❖ Prove Less Daily Attention

❖ Environmental Analysis

